BIOFILTRATION (BF)

The biofiltration methods described in the following section are based on the bioretention design found in the Maryland Stormwater Design Manual, and where deemed appropriate, have been modified by the Montgomery County Department of Permitting Services. DPS currently restricts the use of biofiltration (BF) for the treatment of the water quality volume from catchment areas of 1.0 acre or less. In addition, unless waived by DPS all biofiltration devices shall include a PVC pipe underdrain system.

A. Facility Description

Biofiltration is a soil filtration system. Principal components of the system (*figures 1&2*) include: a.) a pre-treatment grass filter strip, b.) surface planting with woody and herbaceous plant species, c.) a surface 2-3 inch thick mulch layer, d.) a minimum 2 foot thick sandy loam or loamy sand soil-textured planting soil media (See specifications), e.) a 6 inch thick sand layer, and f.) perforated PVC pipe underdrainage within a 15 inch thick gravel bed. The entire system can generally fit into a relatively confined space, thus making it well-suited for incorporation within parking lot designs.

It is strongly recommended that stormwater runoff sheetflow through a grass filter strip into the ponding area. A maximum 12-inch deep ponding depth has been selected so as to reduce the likelihood of creating saturated-soil/anoxic conditions within the system. The perforated PVC pipe underdrain system provides proper drainage and aeration of the planting soil filter layer. Volumes above the water quality volume will pass through the facility via a structural overflow. Excess runoff that cannot be filtered is diverted away from the biofiltration area via a graded grassed swale or similarly acceptable drainage technique.

B. System Design Considerations

1. Applicability

The biofiltration device is appropriate for drainage areas of 1 acre or less, such as parking lots and building additions in highly visible areas. Large biofiltration structures can be expensive to properly landscape and maintain.

2. Design Storm

The facility must be sized to provide storage for the required water quality volume. Peak flows from the 10-year frequency storm must be safely conveyed around the basin whenever possible. See Montgomery County Flow Splitting Criteria.

3. Groundwater

In general, the BF system can not be located where the water table is within 6 feet of the ground surface. In situations where groundwater is encountered, another method for water quality treatment should be considered.

C. Specifications and Details

1. Embankment Criteria

As shown in (*figure 1*) the BF utilizes an embankment with a minimum top width of four feet,

maximum 3:1 side slopes and a core trench. It is imperative that the appropriate underdrain excavation, core trench, and all backfill and embankment requirements are met, since these are permanent facilities. Refer to "Construction Specifications for Shallow Facilities".

2. Sizing

The facility must be sized to store the required water quality volume (WQV). As previously indicated, the maximum ponding depth above the filter bed area is 12-inches. The facility shall be constructed to a 9-inch depth to allow for settlement. Storage is computed above the surface of the facility. The top of the filter media must be level across its entire surface.

Storage volume is determined from the top of the planting media to the crest of the outlet weir or invert of the flow splitter overflow pipe, whichever is lower.

Note: *Biofiltration devices should not be located in areas where the water table is within six feet of the ground surface, within areas which contain mature trees or other environmentally sensitive site features, or where existing slopes exceed 15 percent.*

To the extent possible, structures should have irregular outlines to blend naturally into the environment. Rectangular is not natural.

3. Stormwater Discharge Into Biofiltration Area

Pretreatment through a grass filter is preferred whenever possible. Pretreating runoff may extend the life of the facility. A typical location for the pre-treatment grass filter strip or swale is along the back portion of the facility, adjacent to the planting media. Maximum velocities into the grass filter may not exceed three (3) fps. Particular care must also be taken to prevent erosion of the surface mulch layer. DPS recommends that maximum design storm velocities across the filter bed area not exceed one (1) fps.

4. Overflow Weir Sizing Criteria

Design of the overflow weir, if required, is largely dependent upon the way flows are delivered to the facility. Refer to “Montgomery County Flow Splitting Criteria”. Generally, the overflow weir design is as follows:

a. An overflow weir may not be required where a minimum of one foot of freeboard is provided above the 10-year water surface elevation in the facility.

b. If an overflow weir is necessary, it can be similar to a small emergency spillway and must be located at existing ground level or in cut. If the facility is not fed by a flow-splitter, size the weir to safely pass the full 10-year storm.

   If the facility is fed by a flow-splitter, outlet weir sizes may be reduced, with the outlet weir sized to safely pass whatever portion of the 10-year storm is delivered to the facility. In this case, protection may be provided by permanent turf reinforcement matting only. Utilization of turf reinforcement matting should be considered wherever stream thermal concerns are an issue.

   Individualized designs to safely pass either a flow-split Q or the 10-year storm, both with one foot of freeboard, are necessary. Provide a safe non-erosive outlet below the outfall.

5. Underdrain Pipe

The underdrain pipe consists of 6-inch diameter schedule 40 or stronger perforated PVC pipe at 0.00% slope. The underdrain pipe will be placed within the gravel layer. Three inches of gravel must be placed under the pipe, with a minimum of 6 inches of gravel over the pipe. Perforations must be 3/8 inch in diameter and must be located 4 inches on center, every 90 degrees around the pipe. Perforated pipe must begin at least 5ft. inside the filter media. Filter fabric must **not** be wrapped around the underdrain pipe.

Access for cleaning all underdrain piping is needed. Clean-outs for each pipe should extend 6 inches above the top of the planting media and have a removable waterproof cap.

The required number of underdrain pipes is proportional to the surface area of the biofiltration device. To determine the number of underdrain pipes, multiply the surface area square footage by 0.05. This determines the linear feet of piping required. Use a minimum of two pipes whenever possible. For example, if the surface area of the biofiltration device is 450 square feet, then:

450 (0.05) = 22.5 LF (This should be rounded to the nearest foot.)

Thus, the requirement will be for two underdrain pipes, each 11 feet long. Underdrain pipes should be placed a minimum of 5' apart.

6. Gravel Bed

The gravel layer surrounding the underdrain pipe(s) must meet MSHA size #7 (Table 901A), and must provide a minimum of 6 inches cover over the pipe(s), and minimum 3 inches under the pipe. No geotextile or filter fabric is allowed anywhere within the filter media (stone and sand).

7. Sand Bed

A minimum 6-inch fine aggregate sand layer shall be provided below the soil filter/planting media. A sand window shall extend from the sand filter to the surface of the planting media opposite from the inflow point. *(figure 1).* The sand window will be a minimum of 10 sq. ft. ASTM C33 Fine Aggregate Concrete Sand is required. Manufactured sand or stone dust is not acceptable.

8. Drawdown Time

Drawdown time must be designed to be between 12-24 hours. This will allow the facility to be free to treat consecutive storms, while increasing the treatment time to provide for adequate pollutant removal. Drawdown computations must be submitted to DPS for review. A removable, water tight perforated underdrain cap (1 inch minimum opening) may be used to achieve the drawdown requirement. The perforation must be at the invert elevation of the underdrain pipe. In thermally sensitive watersheds, a 12-hour drawdown time must be used.

9. Soil Filter/Planting Media

The planting media shall consist of 1/3 perlite, 1/3 compost and 1/3 topsoil. The perlite shall be coarse grade horticultural perlite. The compost shall be high grade compost free of stones and partially composted woody material. The soil shall meet the following minimum criteria: contain no more than 10% clay, 30 – 55% silt and 35 – 60% sand. The soil shall be free of stones, stumps, roots or other similar objects larger than 2 inches. The first layer of the planting media shall be lightly tilled to mix it into the sand layer, so not to create a definitive boundary. The planting material shall be flooded after placement. Any settlement that occurs shall be filled back to the design elevation.

10. Mulch

The mulch layer is an important part of the BF. Much of the pollutant removal capacity of the BF is within the mulch layer. The surface mulch layer will consist of standard fine shredded aged hardwood mulch. The mulch should be applied uniformly to a depth of 2 to 3 inches. Yearly replenishing may be necessary. Pine bark is not acceptable.

11. Plant Materials

Plants, through their pollutant uptake and evapotranspiration of stormwater runoff, play a key role in the overall effectiveness of the biofiltration device. Both the number and type of tree and shrub plantings for the system may vary, especially where aesthetics or other considerations are critical to site development. While native plants are encouraged, they are not always appropriate in all situations. While no hard planting rule exists, the plants should be a mix of trees, shrubs and herbaceous materials. However, there should be 2 to 3 shrubs planted per tree and herbaceous plantings shall make up 40 % of the total number of plants. Trees shall be a minimum of 2 ½ in. caliper, shrubs shall be minimum 2 gal. size and herbaceous plants shall be a minimum 1 gal size. Mature plant canopy should cover 85 % of the BF. A landscape plan will be required as part of the plan. The plan will be sealed by a registered landscape architect. Since the plants are an integral part of the BF, no changes to the approved landscape plan will be allowed without prior approval from DPS. An 85% survival rate after 18 months will be required before the asbuilt plan is approved.

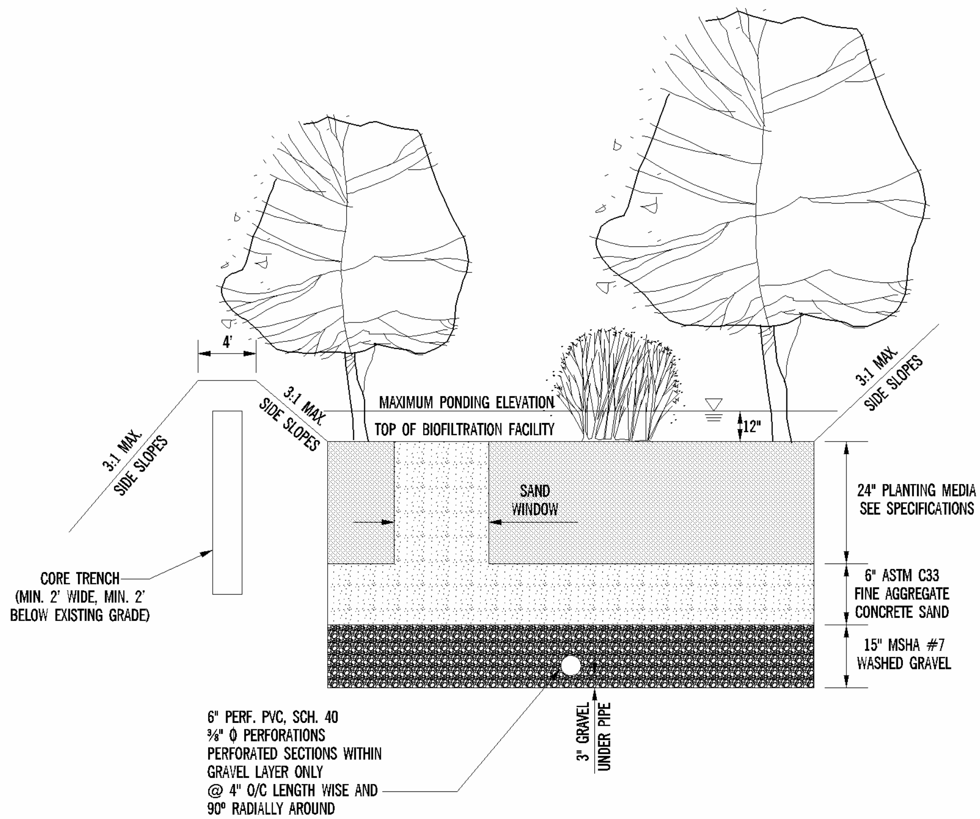
Appendix A contains a list of unacceptable plants.

Appendix A

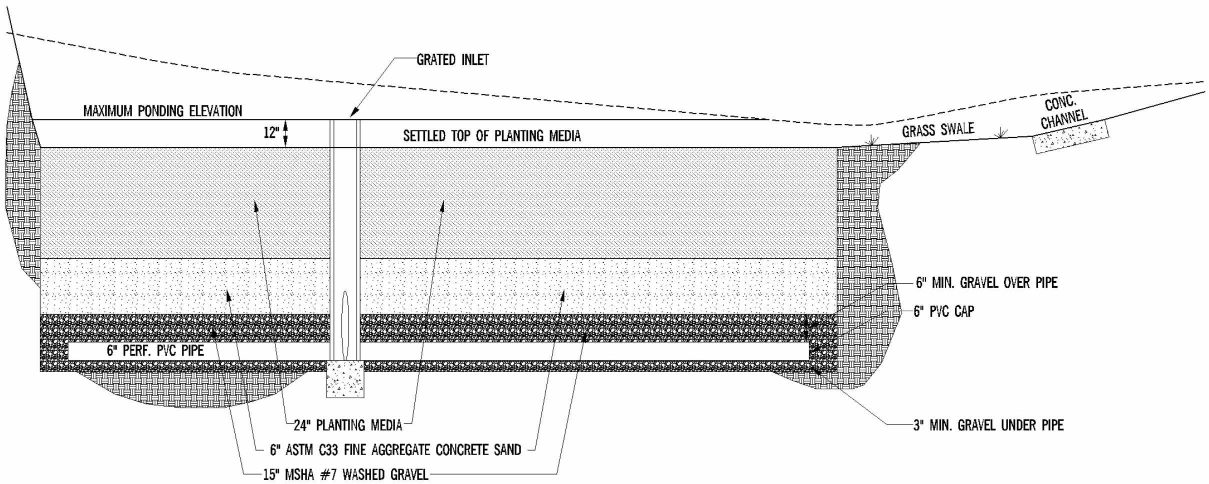
Exotic or Invasive Species

Scientific Name	Common Name	Growth Habit
Acer platanoides	Norway Maple	Tree
Acer pseudoplatanus	Sycamore Maple	Tree
Ailanthus altissima	Tree of Heaven	Tree
Ampelopsis brevipedunculata	Porcelain Berry	Vine
Berberis thunberaii	Japanese Barberry	Shrub
Carduus acanthoides	Plumeless Thistle	Herbaceous
Carduus nutans	Musk Thistle	Herbaceous
Catalpa sp.	Catalpa	Tree
Celastrus orbiculatus	Oriental Bittersweet	Vine
Centuria maculosa	Spotted Knapweed	Herbaceous
Coronilla varia	Crown Vetch	Herbaceous
Eleagnus angustifolium	Russian Olive	Shrub
Eleagnus umbellata	AutumnOlive	Shrub
Eulalia vimineus	Beefsteak Mint	Herbaceous
Euonymus alatus	Winged Euonymus	Shrub
Euonymus fortunei	Climbing Euonymus	Vine
** Hedera helix*	English Ivy	Vine
** Hemerocallis fulva*	Common Daylily	Herbaceous
Ligustrum sp.	Privet	Shrub
Lonicera sp.	Bush Honeysuckles	Shrub
Lonicera japonica	Japanese Honeysuckle	Vine
Lysimachia nummularia	Moneywort	Herbaceous
Lythrum alatum	Purple Loosestrife	Herbaceous
Morus alba	White Mulberry	Tree
Myoston aquaticum	Moneywort	Herbaceous
Paulownia tamentosa	Empress Tree	Tree
Phellodendron amurense	Amur Cork Tree	Tree
Picea glauca	White Spruce	Tree
Prunus avium	Sweet Cherry	Tree
Rhamnus cathartica	Common Buckthorn	Shrub
Rhamnus frangula	European Buckthorn	Shrub
Rubus illecebrosus	Strawberry-Raspberry	Shrub
Rubus phoenicolasius	Wineberry	Shrub
Spiraea japonica	Japanese Spirea	Shrub
Symphoricarpos orbiculatus	Coralberry	Shrub
** Vinca minor*	Periwinkle	Vine
Wisteria floribunda	Wisteria	Vine
Wisteria sinensis	Chinese Wisteria	Vine

Plants marked * can be used in confined areas such as parking lot islands.



**TYPICAL CROSS-SECTION
THROUGH BIOFILTRATION
(PERPENDICULAR TO UNDER-DRAIN)
FIGURE 1**



TYPICAL CROSS-SECTION THROUGH BIOFILTRATION (PARALLEL TO UNDER-DRAIN) FIGURE 2